Title of Diploma Thesis

Three-dimensional Finite Element Analysis of Suction Caissons for Offshore Applications

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ABSTRACT

During the last decades there is an increased interest for alternative sources of energy. The need for utilizing these sources which originates from the demands about dealing with the energy problem forges the turn to the renewable energy sources. The promising solution of onshore and offshore wind turbines is called to play a significant role in this direction. The major advantages which render efficient the installation and operation of offshore wind parks are the exploitation of the available free space and the strong winds that blow in the sea.

However, the general cost of the installation of wind turbines is very high, especially for the offshore ones. Moreover, the specific cost of foundation system consists of a high percentage of the general cost (usually up to 30%). This happens due to the difficulties that emerge from the transportation, the installation and the maintenance of the foundation system.

An alternative and promising solution are the suction caissons. This type of foundation consists of skirted circular footings, the design of which employs a ratio of length to skirt base diameter (B/D) of 0.2 - 0.5 and a ratio of skirt thickness to base diameter (t/D) of 0.02-0.1. The great advantage of this type of foundation is that combines increased bearing capacity with lower cost installation. The mechanism of the installation is achieved by moving the foundation at the initial desired location and then pumping out the water between the skirts, the lid and the soil. The difference between inside and outside pressures leads to the foundation being steadily driven into the ground, just with this mechanism.

This Diploma Thesis attains to evaluate the behavior of suction caissons as a possible type of foundation in offshore wind turbines, which up to date has not been investigated efficiently and as a result is of high research interest. In the following Chapter a thorough literature survey is presented. The aim of this Diploma Thesis is to investigate and assess the behavior of a tripod foundation formed by three suction caissons that are connected rigidly. Specifically, this survey concerns the calculation of the bearing capacity under pure vertical (V), pure horizontal (H), pure moment (M) and also the impact of the increased skirts length to the above sizes. Additional analysis were conducted to investigate the impact of the horizontal load (H) to the pure load cases (V,M) or to their combination (M-V). All the above contribute to the construction of the three-dimensional interaction charts (M-V-H).

The 3D analysis were conducted for a number of different ratio of the suctions distance to base diameter s/D=2, 3, 4 and for a ratio of the length to skirt base diameter B/D=0.5,1 by the finite element software ABAQUS. Also, the normalization of the results attends to the disengagement of the parametric values that were used for the numerical simulation.

Finally, the results and the resultant interaction charts (M-V-H) can be used in practice so that future marine structures founded on suction caissons which lay over a clayey seabed, can be designed regardless of the distance of the footings and

taking into account only the moment direction, the ratio of moment (M) to vertical loading (V) and the value of the horizontal loading (H) as a percentage of the horizontal failure loading H_o, $H=\alpha*H_o$.

Keywords: Three-Dimensional Numerical Analysis, Finite Elements, Offshore Foundations, Suction Caissons, Bearing Capacity